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Effect of Covid-19 on the Air Quality and On Environment in India

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Abstract
During COVID-19 pandemic, certain restrictions had bee imposed by Indian Government and lockdown is one of the measures taken and has proved to be a boon for cleaning the environment. Various studies have been conducted in India and across the world to assess the effect of COVID-19 on the quality of air and on environment. Concentration of major air pollutants like PM_{10}, $PM_{2.5}$, NO_x, NO, NO_2, SO_2 etc. were assessed during the lockdown period i.e., from 25th March 2020 and onwards. The studies revealed that the concentration of these air pollutants have been decreased significantly due to restriction in vehicular, industrial, commercial and other activities during lockdown. So, we all should take lesson from this lockdown and understand our responsibility towards our environment. It is the nature (Earth) only who knows how to clean itself if humans on earth are unable to clean it.

Keywords*: COVID-19, air pollutants, concentration, lockdown.*

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I. INTRODUCTION

The world had faced various unforeseen challenges to cope up with the unprecedented growth of Coronavirus Disease (COVID-19). The spread of the COVID-19 in different countries of the world had made it a global pandemic that has led to serious consequences in different parts of the world. It was first identified in Wuhan region of China inthe month of December 2019 (Kucharski et al. 2020; Sikarwar et al. 2020; Zhu et al. 2020). After four- five months later, it started not only spreading but also its effects have been started seen in various parts of the world (WHO 2020; Sikarwar et al. 2020). Different countries of the world now started facing various issues like health issues, economic challenges, disrupting the life only because of spread of this corona virus (Garg et al. 2021; Sikarwar et al. 2020; WHO 2020).Impact of COVID-19 on the health of humans includes impact on the respiratory system, impact on cardiovascular & metabolic systems, neurological system. In ambient air, pollutants and respiratory viruses show complex interactions (Bourdrel et al. 2021).

In order to curb the spread of this communicable disease and to lessen the fatality rate, different countries have adopted very important and strict measures so as to reduce interaction among individuals. Depending upon the country's situation needed steps have been taken such as strict quarantine instructions, imposing a curfew and banning of largescale public and private gatherings,promoting social distancing,restraining transportation, and locking down the cities, states and countries (Ministry of Home Affairs, 2020; Sikarwar et al. 2020).

In March 2020,In India, when the COVID 19 cases hits the value of 500, India has announced the complete lockdown. The lockdown norms were very strict in Indian cities which ban the stepping out of people from their homes (Ministry of Home Affairs, 2020).The various lockdown phases in India have a difference inrestrictions like in the first lockdown phase, all humanactivities were not allowed except for emergency services. After that, in next consecutivephases, there was a bit relaxation in the movement of people like movements of people stuckin lockdown, relaxation in timings to buy market goods but with proper COVID-19 guidelines and the opening of essential industries, were allowedwith few limitations and by following COVID-19 norms (Ravindra et al. 2020).Despite of so many economic and other challenges, some positive things have been observed during this pandemic situation which includes improvement in air quality, water quality as well as the quality of our environment(Kerimray et al. 2020; Ravindra et al. 2020; Sharma et al.2020).

According to the report of World Health Organization (WHO), 2016, Delhi, the capital of India is one of the most polluted cities in the world. In Delhi, the high levels of Particulate Matter (PM_{10}& $PM_{2.5}$) and nit Nitrogen Oxides (NO_x) have always been a matter of severe threat for public health due to its exceeding value from the permissible limit of ambient air quality standards setup by Central Pollution Control Board (CPCB) of India. Because of the industrialization, rapid urbanization and commercialization in Delhi and its nearby areas, results in degrading its air quality (Garg et al. 2021). Other causes of air pollution in these areas includes the

increase in number motorized vehicles and in industrieswhich contributes to air pollution and also results in the release of various air pollutants such as Particulate Matter (PM_{10}, $PM_{2.5}$), Sulfur Oxides (SO_X), Nitrogen Oxides (NO_X), Ammonia (NH_3), Carbon Monoxide (CO), Volatile Organic Compounds (VOCs), Ozone (O_3), Polycyclic Aromatic Hydrocarbons (PAHs) etc. (Garg and Gupta 2019; Garg et al. 2021; Singh and Peshin 2014; Sharma et al.2014).

During the very first lockdown imposed in India, it has been observed that the air pollution levels of the most polluted city came below or within the permissible limit of ambient air quality standards setup by CPCB of India (CPCB, 2009; Garg et al. 2021).

Variousrecent studies have beenconducted on the impacts of lockdown due to COVID-19 on the air quality (Li et al.2020; Nigam et al. 2020; Sharma et al., 2020; Kerimray et al., 2020). During the lockdown phases, all vehicular, industrial as well as commercial activities were restricted, so, ideal condition was there for investigating various effects of pollution reduction and in cleaning the environment (Garg et al. 2021).

IMPACTS OF LOCKDOWN IN VARIOUS CITIES OF INDIA

In various cities and megacities of India, Studies have been conducted in order to assess the impacts of lockdown on the air quality as well as on the quality of environment and are discussed as under:

Garg et al. 2021assessed the impacts of lockdown on ambient air quality in five cities of Indian National Capital Region including Delhi, Gurugram, Noida, Ghaziabad and Faridabad. For this study, data for pollutants (PM_{10}, $PM_{2.5}$, NO_x, NO, NO_2, SO_2, NH_3, SO_2, CO, and C_6H_6) from 36 locations of the study area were analyzed from 1st March 2020 to 1st May, 2020. The results showed that PM_{10} and $PM_{2.5}$ level decreased upto 55–65 %. NO_x and NO have shown maximum reduction (50–78 %), also there was reduction in other air pollutants like SO_2 (33 %), CO (45 %), NH_3 (27 %) and C_6H_6 (53 %) has been observed.Air Quality Index (AQI) during lockdown showed improvement as its value has significantly decreased (45 %–68 %). Important observation made was that during first week of lockdown, Ozone (O3) decreased but later it increased by 19 - 27%. The study suggests that this pandemic gives lessons for interventions for urban air pollution mitigation in controlling the health impact due to urban air pollution.

A study on the effect of COVID-19 lockdown on air quality of industrial cities (Ankleshwar & Vapi) of western India has been conducted by Nigam et al. 2020. Air Quality Index (AQI) was calculated for the main air pollutants include $PM_{2.5}$, PM_{10}, NO_2, SO_2, Pb & NH_3 and found the decrease upto 30-84% in NO_2, 35% in $PM_{2.5}$ while O_3 increases upto 16-48% due to reduction in NO_2. Average decrease in AQI upto 58% is seen in industrial areas of Gujarat. Negative correlation between air quality index values of Ankleshwar & Vapi shows that the majority of air pollution decreases as the lockdown period got extended.

Impacts of COVID-19 lockdown on ambient air quality in 5 Indian Megacities (New Delhi, Chennai, Kolkata, Mumbai & Hyderabad) has been studied.The impact was studied for pre-lockdown (1st Mar–24th Mar 2020), lockdown (25th Mar–31st May 2020), and unlocking (1st Jun–31st Aug 2020) phases. Study found that $PM_{2.5}$ concentration reduced significantly in all megacities and met the national standards during the lockdown period. The maximum reduction in $PM_{2.5}$ level was observed in order- Kolkata (62%), Mumbai (49%), Chennai (34%), and New Delhi (26%) during the lockdown period. Hyderabad showed a smaller reduction in $PM_{2.5}$ concentration (10%). The average $PM_{2.5}$ levels during the lockdown in the peak hour (i.e., 07:00−11:00 h) in New Delhi, Chennai, Kolkata, Mumbai, and Hyderabad decreased by 21.3%, 48.5%, 63.4%, 56.4%, and 23.8%, respectively, compared to those before lockdown period. During the unlocking period, all megacities showed a reduction in average $PM_{2.5}$ levels when compared to concentrations in the lockdown period except for Chennai. The study reported a new baseline of $PM_{2.5}$, except for monsoon, provides knowledge to plan future air pollution reduction strategies, also strengthen air pollution control policies for better air quality and sustainability (Ravindra et al. 2020).

In order to analyze the levels of 3 major pollutants ($PM_{2.5}$, PM_{10}& NO_2) before and after lockdown in Delhi, a study has been done by Sikarwar et al. 2020. The data for these 3 pollutants were derived from 38 ground stations dispersed within the city. The spatial interpolation maps of pollutant for 2 hours are generated using Inverse Distance Weighing (IDW). The results have shown the decrease in concentration of these pollutants by 93%, 83% & 70% from 25th Feb 2020- 21st April 2021. It was reported that the air quality in Delhi during Lockdown has beenupgraded.

Bourdrel et al. 2020 studied the impact of outdoor air pollution on COVID-19. In this study, they provided evidence from in-vitro animal & human studies from the existing literature. Experimental studies conducted for respiratory viruses support the hypothesis that air pollution exposure may facilitate the occurrence of COVID-19 infection through a decrease in immune response. In-vitro, animal & human studies have reported that exposure to air pollutants lead to mucosal permeability & oxidative stress, decrease antioxidants & surfactant antimicrobial proteins as well as macrophage phagocytosis. In addition, SARS-CoV-2 entry in host cells through ACEZ requires the cleavage of viral spike protein. This activity can further be increased by air pollution. That means both surrounding environment and infectious diseases can enhance the spread of this

virus. So, they recommend the reduction of air pollution from all sources especially from road traffic and heat generation.

II. DISCUSSION

Environmental pollution due to anthropogenic sources pollution has become a chronic problem the world over.In India, urbanization and industrialization on the name of development has led to various problems such as land degradation, air pollution, water qualitydegradation and many more environmental issues. Air pollution has become a severe problem in various cities of India as well as across the globe (Nigam et al. 2021). Sources of air pollution includes incomplete combustion of fossil fuels, vehicular emissions, mini-industries &industrialoperations,improper disposal of anthropogenic waste, waste burning,dust from constructional activities, atmospheric chemistry of pollutants, emission sources suspension of dust particles in air, meteorological conditions(Nigam et al. 2021; Garg et al. 2021; Ravindra et al. 2020). If the concentration of air pollutants like PM_{10}, $PM_{2.5}$, NO_x, NO, NO_2, SO_2, NH_3, CO, C_6H_6 etc. increases in air, then these are responsible for air pollution and are also responsible for cardiovascular and respiratory diseases (Nigam et al. 2021; Bourdrel et al. 2020).

In India during March 2020, the COVID-19 pandemic led to a lockdown in whole of the country in order to control the spread of infection.The total stretch of various phases of lockdown was 68 days, in which the restrictions were eased subsequently (Kumari et al. 2020; Ravindra et al. 2020; Nigam et al. 2021).This measure taken by government proved to be boon for the environment as during this lockdown environment has healed itself without the interference of humans. As there were restrictions on human activities during this lockdown which results in decrease in concentration of air pollutants in most of the cities of India.

In Delhi, India, it is reported by Sikarwar et al. 2020 that there is decrease in the concentration of $PM_{2.5}$, PM_{10} and NO_2 by93%, 83%, and 70% respectively during the lockdown days in Delhi. Reductions up to 30–84% inNO_2concentration was observed, while Ozone (O_3)concentration has been increased by 16–48% due to reduction in NO_2in Saurashtra and South Gujarat regions in Gujarat state of India (Nigam et al. 2021).

The reduced levels of air pollutants' concentration even in the most polluted city i.e., Delhiduring this lockdown period has been reported by Garg et al. 2021. The concentration of PM_{10}, $PM_{2.5}$, NO_x, NO, NO_2, SO_2in Delhi and its nearby regions were decreased by 61.6 %, 60.0 %, 58.6 % 62.3 %, 46.8 %, and 33.8 % respectively. Ravindra et al. 2020 reported in the study that maximum reduction in $PM_{2.5}$ concentrations was observed in Kolkata (62%) which was followed by Mumbai (49%) and then Chennai (34%), New Delhi (26%) and in last Hyderabad (10%).

Thereduction in concentration of air pollutants could be because ofseveral reasons like closing of food eateries (street food vendors, semi-open cooking in restaurants using tandoors), strict measures takenduring the lockdown by Indian Government which includeslimiting public and private transport, shutting down of industrial and commercial activitieswhich lead to decrease in emissions from both vehicular and industrial exhaust.As a result, there was decrease in the concentrations of various pollutants to several strict measures, taken such as the concentration of different pollutants PM_{10}, $PM_{2.5}$, NO_x, NO, NO_2, SO_2, NH_3, CO, C_6H_6 etc.(Garg et al. 2021; Nigam et al. 2021; Kumari et al. 2020; Sikarwar et al. 2020). However, two main causes for the reduction in concentration of some air pollutants were industrial setup and decline in the number of the on-road vehicle has been reported by Nigam et al. 2021and also reported that due to the mandatory lockdown imposed in India, a drastic reduction in air pollution have been observed in 88 Indian cities.

Table 1: Showing decrease in the concentration of air pollutants in various cities of India

References	**Cities/ States of India**	**Dec. in conc. of $PM_{2.5}$**	**Dec. in conc. of PM_{10}**	**Dec. in conc. of NO_2**	**Dec. in conc. of SO_2**	**Inc. in conc. of O_3**
Garg et al. 2021	Delhi	60%	61.6%	46.8%	33.8%	19.27%
Sikarwar et al. 2020	Delhi	93%	83%	70%	-	-
Kumari et al. 2020	Delhi	49%	55%	60%	19%	-
Nigam et al. 2021	Ankleshwar, Gujarat	25%	29%	80%	-	192%
Nigam et al. 2021	Vapi, Gujarat	48%	52%	91%	-	310%
Kumari et al. 2020	Mumbai	37%	44%	78%	39%	-

Dec.- decrease, conc.- concentration, PM- Particulate matter, NO_2- Nitrogen dioxide, SO_2- Sulphur dioxide, O_3- Ozone.

III. CONCLUSION

The role of this review paper is to acknowledge the role of lockdown in curbing air pollution. Hence, humans now must understand the deleterious effects of anthropogenic activities. Conclusions can be derived on the basis of literature survey doneand are given as under:

- It is undoubtedly concluded from these studies that the lockdown measures imposed by the Indian Government was very effective resulting in the positive impact during pandemic as blessing.
- When urban mega hubs have been runningcontinuously for economic development without considering the limits of natural resources, measureslike temporary lockdown may emerge as an effective solution to control environmental imbalance.
- Overall results of the studies showed that the atmospheric chemistry of pollutants, the emission sources, the meteorological conditions play a major role in identifying the levels of ambient air pollutants.
- Restoration ability of environment to restore itself and health as well as improved air quality.
- Reduction in the concentration of air pollutants like $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO_2, CH_4 etc. because of the restrictions on various anthropogenic activities.
- Not only air quality has improved but also water quality as well as overall quality of the environment has been improved.
- Also helps the decision makers and policy makers to frame policies to combat the problem of air pollution based on lockdown impacts.
- Thus, it is the nature only who knows how to clean itself if humans on earth are unable to clean it. So, we all should take lesson from this lockdown and understand our responsibility towards our environment.

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